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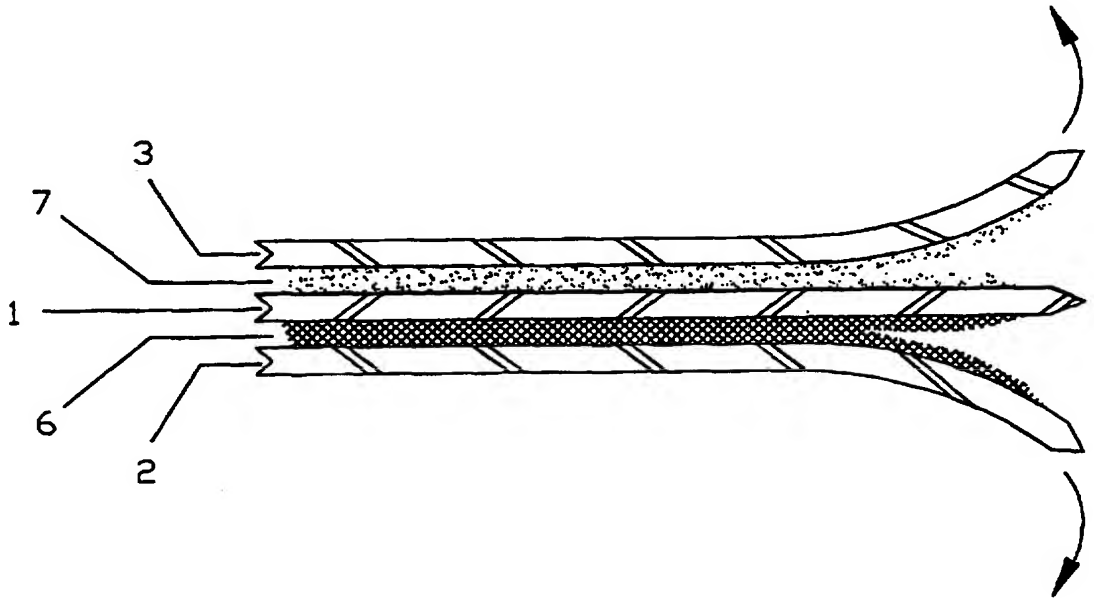

(57) Abstract

This invention relates to the manufacture of continuous-sheet, adhesively bonded paper laminates of three or more plies (1, 2, 3). The sheets are preferably made by flexographic printing using a novel controlled adhesive (6, 7) strike-through technique. The multi-ply laminates of this invention are especially suited for paper products such as disposable table napkins, since they can be printed to the edge without embossing or loss of registration.

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MANUFACTURE OF MULTI-PLY PAPER LAMINATES USING CONTROLLED ADHESIVE STRIKE-THROUGH

BACKGROUND OF THE INVENTION

Field of the Invention

Our invention relates to the manufacture of continuous-sheet, adhesively bonded paper laminates of three or more plies made by using a controlled adhesive strike-through technique, in which multiple junctures between plies are attained using a single application of adhesive. The multi-ply laminates of our invention are especially suited for color-printed paper products such as disposable table napkins, since our laminates can be color-printed to their edges without the loss of registration that ordinarily accompanies edge embossing.

Description of the Prior Art

Conversion processes for making such products as three-ply paper napkins typically rely on edge embossing to hold the plies together. In older flexographic printing presses designed for converting roll paper into napkins, the cutting and edge embossing steps typically precede the color printing operation. As a result, it is difficult or impossible to print colors out to the edges of the finished napkins because adequate registration of colors cannot be attained on the embossed edges. Thus, the printing on most colored paper napkins is restricted to the unembossed center of the napkin.

Some newer flexographic presses designed to convert rolled three-ply paper to paper napkins put the edge embossing operation after color printing. But these machines are also subject to registration problems when using loose, non-adhered three-ply paper.

Moreover, since the individual plies in multi-ply paper napkins made on both older and newer equipment typically are attached to each other only at the embossed areas (usually limited to the edges), novelty napkin shapes cannot be cut because the plies separate from each other. As a result, for practical purposes paper napkins are almost always limited to square shapes.

Prior art attempts to address these problems have used adhesive to bond the plies together, thus reducing or eliminating the need for edge embossing. But such prior art processes have required multiple adhesive applicator stations, typically one such station for each boundary between plies. Thus, for example, a three-ply laminate required two applications of adhesive. Moreover, where adhesive was applied between plies by spraying, much more adhesive than necessary was used to stick the plies together.

Thus, prior art approaches to the problem of achieving ply adherence over the entire laminate surface required an additional set of adhesive application rolls for each added ply. This contributed to the complexity and cost of the prior art processes.

BRIEF SUMMARY OF THE INVENTION

We have found that multi-ply laminates can be made using a novel process that relies on controlled strike-through of adhesive from one surface of a carrier sheet to the other. This permits one or more additional plies to adhere to the side of the carrier sheet opposite that to which adhesive was applied. By controlling the basis weight and air flow porosity of the carrier sheet and the added plies, as well as the

adhesive properties and set time, three or more plies can be joined with only one application of adhesive. It is unnecessary to apply any heat to ensure proper adhesive strike-through. And napkins made from the our laminate can be printed out to their edges without loss of color registration and with about 25% less waste than is ordinarily experienced in converting non-adhered three ply laminate to paper napkins via edge embossing.

In a preferred embodiment of our invention, a flexographic impression process is used to apply adhesive to the carrier sheet. In manufacturing a three-ply laminate using plies having a basis weight of about 9.7 lbs per 3000 ft^2, we achieved very acceptable peel strengths between all three plies at polyvinyl alcohol adhesive coverage levels of only 1% to 2% of the paper surface. Only one adhesive application was used to adhere all three plies together. Other embodiments of our invention include a variety of processes using alternate adhesive application techniques, while still achieving controlled adhesive strike-through.

Although the manufacture of paper napkin feedstock is an important application of our invention, there are other uses too. These include such applications as making three-ply table covers in which one ply may be a liquid-impermeable plastic sheet; reinforced laminates in which the carrier sheet is selected from one of a number of strong synthetics; paper/metal laminates such as chewing gum wrappers; and quilted laminates including one or more very high-bulk layers.

It is an object of this invention, therefore, to provide multi-ply paper laminates by applying only one adhesive layer to achieve two or more junctures between sheets.

It is another object of this invention to provide such multi-ply laminates in which comparable peel strengths are achieved between layers.

It is still another object of our invention to minimize the amount of adhesive used to achieve bonding between multiple plies of laminate.

It is a further object of this invention to provide a flexographic process for manufacturing such laminates, as well as other process alternatives.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a drawing of a three-ply laminate made using the process of this invention, showing the two outer plies being peeled back from the central carrier sheet.

Figure 2 is a schematic showing a flexographic printer setup that has been specially modified to make a three-ply laminate using our invention.

Figure 3 shows a flexographic plate roller equipped with a rubber mat of one design that we have found suitable for practicing our invention.

Figure 4 is a schematic showing an alternate, special flexographic printer setup that can be used to make a five-ply laminate using our invention.

Figure 5 is a schematic of a rotogravure-type press specially modified to practice our invention.

Figure 6 is a schematic of a press in which a special pressurized roller is used to practice our invention.

Figure 7 shows one possible pressurized adhesive feed arrangement for the roller of Figure 6.

Figure 8 is a schematic of an alternate process for practicing our invention using sprayed-on lines of adhesive.

Figure 9 shows an adhesive sprayer for applying parallel lines of adhesive.

Figure 10 is a schematic of another alternate process for practicing our invention using a hot-melt adhesive.

Figure 11 illustrates a laminate made using controlled strike-through in which the characteristics of the plies are chosen to allow several adhesive patterns to be created on one side of the carrier sheet.

Figure 12 shows a quilted laminate made using a high-loft carrier sheet.

Figure 13 shows one rubber mat pattern suitable for producing the quilted laminate of Figure 12.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring initially to Figure 1, the structure of a three-ply laminate made according to this invention comprises a carrier sheet 1, a second ply 2, and a third ply 3. The second and third plies are shown being peeled away from the carrier sheet. Between the plies and the carrier sheet are the initially-applied adhesive pattern 6 and the struck-through adhesive pattern 7.

Figure 2 illustrates a preferred embodiment of our invention, using a flexographic press to apply the adhesive. Carrier sheet 1 and third ply 3 are spooled together on unwinder 9. They are unwound from unwinder 9, around tension roller 18 and from there to the nip 16 between plate roller 11

and impression roller 4. Adhesive 6 is applied to one surface of carrier sheet 1 from textured rubber mat 15 on the exterior of plate roll 11. At the nip 16, controlled strike-through of the initial adhesive pattern 6 begins.

Carrier sheet 1 and third ply 3 travel further around impression roller 4 to bottom calendar roll 5. At that point, first ply 3 (which is unwound from unwinder 13 and fed past tension roller 19) is pressed against adhesive pattern 6 at nip 17. The high pressure exerted between bottom calendar roll 5 and impression roll 11 completes the operation of forcing adhesive through carrier sheet 1 to form struck-through adhesive pattern 7. From nip 17 the finished three-ply laminate proceeds to rewind 14, onto which the completed roll is wound.

In this preferred embodiment of our invention, adhesive is applied to anilox roll 10 by means of a reverse angle double doctor blade system 12. Anilox roll 10 transfers the adhesive to the raised pattern on rubber mat 15 just as ink is applied in an ordinary flexographic printing operation. As an alternative to reverse angle double doctor blade system 12, anilox roll 10 may revolve against a fountain roll (not shown), which in turn picks up adhesive from a feed trough (also not shown).

We have found that one suitable pattern for rubber mat 15 is one utilizing 1/32 inch dots in a diamond-shaped pattern on 0.265 inch and 0.370 inch centers. See Figure 3. This pattern provides approximately one percent area coverage, which we have found is more than sufficient for a three-ply product. Another suitable pattern uses 1/16 inch dots and provides an area

coverage of 3.1%. Generally, larger dots provide increased adhesive penetration and are especially suited for use with low airflow papers.

Preferred sheet speed for this embodiment is between 50 to 3000 fpm, with the most preferred range being 530 to 2500 fpm. At the lowest speeds the adhesive tends to set between the point of application of adhesive to the rubber mat 15 and the transfer of the adhesive to the carrier sheet 1 at nip 16, causing some buildup of fiber on the rubber mat 15. The upper sheet speed limit depends primarily upon equipment capabilities.

The suitable amount of "squeeze," or interference, at nip 16, where adhesive is applied, is between 0.002 inch to 0.003 inch. High pressures should be used between the impression roller 4 and the bottom calendar roll 5, to facilitate strike-through. We find that pressures up to about 300 lbs per linear inch (pli), or more, are suitable. Pressures above 50 pli and below 300 pli are especially preferred.

Our invention requires suitable matching of the properties of the carrier sheet, the other plies and the adhesive characteristics. It is significant that, with proper choice of adhesive type and carrier sheet characteristics, no heat need be applied to facilitate strike-through of the adhesive. We discuss those factors below.

Figure 4 illustrates an embodiment of our invention making a five-ply laminated product. This can be accomplished by adding an additional unwinder 20 on which a second carrier sheet 21 and a fifth ply 22 are spooled. Adhesive is applied to second carrier sheet 21 by a second plate roll 26 bearing

another rubber mat 27, which in turn is fed by a second anilox roll 25 and by another reverse angle double doctor blade 24. Three-ply laminate can be fed directly to the nip between second impression roll 28 and second bottom calendar roll 31 from an initial production operation of the sort shown in Figure 2. The finished five-ply product is then spooled on winder 32.

Alternatively, of course, a laminated product having five or more plies can be made in two passes through the equipment shown schematically in Figure 2. In that case, three-ply laminate made in an initial pass is spooled off of unwinder 13, with two additional plies added from unwinder 9. The operation of our process is otherwise similar to that described above.

It will be understood by those of ordinary skill that laminates having even numbers of plies also can be created using the process of our invention, simply by using a step in which only one additional ply, instead of two, is added. All such variations are within the scope of our invention, which we intend to limit only as set forth in our claims.

Referring now to Figure 5, we show another embodiment of our invention in which the flexographic adhesive application method using an anilox roll and a rubber mat is replaced by a an engraved roll 40 turning against a flat roll 41, an arrangement similar to a rotogravure press. Adhesive pattern 46 is applied to carrier sheet 38 from reservoir 39 via the pattern on engraved roll 40. Carrier sheet 38 and third ply 37 are fed from unwinder 36. First ply 44 is fed off of unwinder 43 and meets the carrier sheet at the nip between flat roll 41 and flat roll 42. This creates adhesive pattern 47

between carrier sheet 38 and third sheet 3, as in the embodiment of Figure 2.

Figure 6 illustrates yet another embodiment, in which adhesive is pumped from reservoir 49 by pump 50 to a plurality of holes 52 in the periphery of a perforated drum 48. The periphery of drum 48 rotates against impression roll 4. This creates adhesive pattern 6. Figure 7 shows a detail of one possible feed system for perforated drum 48. In this embodiment, adhesive feed pipe 53 terminates at plenum 54 on one end of drum 48. Feed holes 55 drilled in the periphery of drum 48 and parallel to the axis of drum 48 contact plenum 54, which remains immobile as drum 48 rotates. Adhesive then moves through feed holes 55 and out perforations 52, thus producing a dot or other desired pattern of adhesives on the carrier sheet. Alternatively, of course, the whole interior of drum 48 could be pressurized with adhesive.

Figures 8 and 9 illustrate yet another possible adhesive feed arrangement. In this embodiment, adhesive is pumped under pressure into feed line 56, from which it sprays in a series of jets 58 from a plurality of holes 59 onto carrier sheet 1. The result is parallel lines of adhesive along the length of the roll of laminate. This embodiment eliminates need for any system of adhesive feed rolls.

Figure 10 illustrates yet another embodiment of our invention, utilizing a hot melt adhesive. In this embodiment, a two-ply roll comprising carrier sheet 67, third ply 68 and hot melt adhesive pattern 66 (which can be applied by a variety of techniques known in the art) is first spooled onto unwinder 60. The two-ply roll, with the two plies as yet unattached to

each other, is spooled off of unwinder 60 and between heated roll 65 and pressure roll 72 (which also may be heated, if desired). At the same time, first ply 69 is fed from unwinder 61 to the nip between heated roll 65 and pressure roll 72. This melts the hot melt adhesive pattern 66 sufficiently to cause it to strike through carrier sheet 67 onto third ply 68, while also attaching first ply 69. The resulting three-ply laminate is spooled onto winder 71.

It will be apparent to those of ordinary skill that a variety of other equipment arrangements can be used to practice our invention. For example, other adhesive application trains are possible. We intend to include all such variations, limiting our patent only as set forth in our claims.

DESCRIPTION OF MULTI-PLY LAMINATES THAT CAN BE PRODUCED USING OUR INVENTION

The simplest three-ply laminate that can be produced using our invention is shown in Figure 1. In that structure, adhesive pattern 6 is applied to one surface of carrier sheet 1, and our process causes that pattern to strike through the carrier sheet creating adhesive pattern 7 on the opposite surface. The characteristics of carrier sheet 1 are chosen to facilitate adhesive strike through; the characteristics of first ply 2 and third ply 3 are chosen to minimize or prevent adhesive striking through those plies.

It is also possible to make laminates using controlled strike-through of adhesive to attach multiple plies to one side of a carrier sheet. Figure 11 illustrates such an arrangement. In this embodiment of our invention, carrier sheet 1 is chosen to have a very open structure (using the criteria outlined

below); first ply 2 is selected for a much less open structure as is fourth ply 73. Third ply 3 is chosen to have an open structure like carrier ply 1, thus allowing adhesive to strike through third ply 3 as well as through carrier ply 1. This creates adhesive pattern 72 between third ply 3 and fourth ply 73, while preventing strike-through of adhesive past first ply 2 or fourth ply 73. By selecting intermediate levels of openness (as preferably measured by air flow tests) for intervening plies, similar peel strengths can be maintained for several adjacent plies while still employing only one adhesive application operation. Or, if desired for some special purpose, one or more plies can be made much easier to separate from the remainder of the structure by limiting adhesive penetration through those plies. We call this balancing of sheet properties against adhesive penetration to ensure adequate adhesion between plies while avoiding strike-through of the adhesive to the outer surfaces of the outermost plies "controlled strike-through."

In still other embodiments of our invention, not all plies need be made of paper. For example, one or more of the exterior plies can be flexible metallized sheets, as in chewing gum wrappers. Similarly, the carrier sheet may be a synthetic spunbond having suitable air flow characteristics. Such a carrier sheet adds strength to the laminate. Plies of variable strength also can be used to make such items as microwaveable popcorn bags. In that instance, sheets and adhesive are selected to provide strength while retaining ability to release moisture during popping.

Another structure that can be made using our invention is shown in Figure 12. In this embodiment, rubber mat 15 is patterned with a diamond-shaped criss-cross pattern of raised lines 78 as shown in Figure 13, in order to lay down a diamond-shaped or quilted adhesive pattern 75. That pattern is applied to a high-loft or highly creped carrier sheet 74, which is spooled on an unwinder together with a much tighter third ply 76. A first, much tighter ply 77 is provided on a separate unwinder. The process embodiment illustrated in Figure 2 may be applied, causing the adhesive pattern 75 to strike through the high-loft carrier sheet 74 and create a corresponding diamond-shaped adhesive pattern 78 holding the high-loft carrier sheet to third ply 76. The result is a sealed paper sheet having excellent insulating properties due to its high loft, but with stronger and tighter exterior plies. Such a laminate is ideal for disposable hospital gowns. Optionally, the exterior plies can be made of water-resistant synthetics to create a laminate that also sheds water. One use for that laminate is for disposable table covers.

The following table shows a selection of paper types that are suitable for use in various embodiments of our invention.

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TABLE 1

Tissue Type	Basis Weight #/3000 ft^2	Air Flow CFM	% Stretch	MD Tensile Strength #/inch	Zero Load Caliper inches
Dry crepe	13.5	500	80	0.3	.014
Dry crepe	11.0	275	50	0.5	.011
Dry crepe	10.5	160	22	0.7	.006
Dry crepe	9.7	120-140	12	1.1	.003
Dry crepe	14.0	20-30	7	2.7	.004
Wet crepe	14.0	50	4	5.0	.004
Machine glaze	12.5	<1	0	6.0	.002
Synthetic spunbond	0.5 oz/yd^2	600	20	2.5	.007
Synthetic spunbond	1.0 oz/yd^2	300	40	5.0	0.13

The natural paper types are arranged in order of descending openness, as shown primarily by airflow. We prefer to determine airflow using an air flow tester manufactured by U.S. Testing Co. of Hoboken, N.J. Airflow is measured in cubic feet per minute (CFM) over one square foot of fabric at a pressure drop of 0.50 inches of water. For use as a carrier sheet, we have found that an airflow of at least about 40 CFM is required. The higher the airflow, the greater the amount of penetration of adhesive for a

given adhesive viscosity. Both of the synthetic spunbonds shown are suitable for use as carrier sheets.

For intermediate plies such as that shown as reference numeral 3 in Figure 11, it may be desirable to use an intermediate airflow figure. Typically airflows in the range of about 50 to about 100 are preferred, depending upon the number of plies desired.

For use as exterior plies (those plies shown in Figure 11 at reference numerals 2 and 73, for example), a less open paper is desired. Preferably plies having airflows of less than about 50 CFM, and still more preferably less than about 20 CFM, should be used. This helps avoid undesirable adhesive strike-through. Neither of the synthetic spunbonds shown in the foregoing table would be suitable as exterior plies.

Under some circumstances the water content of the paper may become important. We prefer water contents above 3% since excessive dust can be created below that level.

It can be seen from the foregoing table that the basis weight of individual plies can be controlled over a fairly wide range independently of their suitability for use as carrier sheets or exterior plies.

DESCRIPTION OF SUITABLE ADHESIVES

A wide range of adhesives can be used in our invention, providing that care is taken to match the viscosity and other properties of the adhesive, as applied, with the openness of the carrier sheet chosen. The following types of adhesives may be employed: silicates (especially sodium silicate); animal glue;

fish glue; casein glue; soybean glue; starch-based adhesives; borated dextrin such as National Starch and Chemical Company's 13-1200 and 13-1558; polyvinyl alcohols such as National Starch and Chemical Company's 18-1535; ethylene vinyl acetates and cellulose adhesives. In addition, natural and reclaimed rubber adhesives; butyl rubber and polyisobutylene; nitrile rubber adhesives; and styrene-butadiene rubber adhesives are among the latex-type adhesives that may be employed. A third category of adhesives is the thermoplastic rubber adhesives of the A-B-A block copolymer variety.

In particular, we have found that polyvinyl alcohol (PVA) adhesives such as Adhesive No. 18-1535 manufactured by the National Starch and Chemical Company of Bridgewater, New Jersey provides a suitable base for making down the adhesive used in our process. This adhesive can be used full strength, at a viscosity of approximately 2500 centipoise for use at 3.1% coverage from 1/16 inch dots with a natural carrier sheet having a basis weight of 9.7 lbs/3000 ft^2 and an airflow of approximately 120 to 140 CFM.

Another suitable adhesive is CYCLOFLEX™ L33-9600, also available from National Starch and Chemical Company. For use with a 9.7 lbs/3000 ft^2 basis weight carrier sheet having an airflow of about 120-140 CFM, this starch-based adhesive can be used in the range of 50 to 700 centipoise viscosity, although better performance is attained near the lower end of this range. In particular, the viscosity range of 50 to 200 centipoise is especially preferred with this adhesive. Generally speaking,

adhesive viscosities in the range of 50 to 5000 centipoise can be used if appropriate paper types are selected.

For viscosities well outside the foregoing ranges, we have found that the use of a lower viscosity adhesive results in excessive puckering, whereas adhesive of a higher viscosity does not produce satisfactory peel strength between the carrier sheet and the third ply (shown, for example, as reference numeral 3 in Figures 1 and 2).

DETAILED DESCRIPTION OF THE PROCESS

Turning now to the specific process conditions that can be used to practice our invention, it should first be understood that one very important goal is to provide laminates that not only possess sufficient peel strength between each ply to hold the plies together, but also for most applications to match the peel strengths so as to avoid very large differences in peel strength between various plies. This prevents preferential delamination of one ply from others, which in most instances is undesirable. More specifically, we have found that the ratio of the lowest mean peel strength to the highest mean peel strength should exceed 20% for best results.

Peel strength can be measured using a variety of equipment. We prefer to measure 180° peel strength using a Thwing-Albert Model 225-1 friction/peel tester, manufactured by the Thwing-Albert Instrument Company of Philadelphia, Pennsylvania. We use a three inch wide strip of laminate, since variability tends to increase if thinner strips are tested. In the examples which follow, we conducted the tests at a separation

rate of 15 inches per minute for a 20 second time period, measuring both peak and mean peel strengths in grams per 3 inch width.

For comparison purposes, peel strength measurements were made on two commercially available 10 lb/3000 ft^2 three-ply laminates manufactured by Lincoln Pulp and Paper Co. of Lincoln, Maine. The Lincoln laminates had been converted to napkins, one having a tulip pattern and a heavy yellow color and the other having a rose pattern and a heavy pink color. Three peel strength tests were run on each of the two junctures between layers. The tests denoted "T" measured the peel strength between the middle sheet and the top ply, while the tests denoted "B" measured the peel strength of the adhesive layer between the middle sheet and the bottom sheet.

Yellow Tulip (Lincoln Converted) (heavy color)

	Maximum (Peak) Peel Strength gr/3 inches	Mean Peel Strength gr/3 inches
T		
1.	11.8	4.8
2.	14.8	5.2
3.	16.9	5.5
B		
1.	12.7	4.7
2.	12.4	5.5
3.	14.0	5.0

Pink Rose (Lincoln Converted) (heavy colored)

	Maximum (Peak) Peel Strength gr/3 inches	Mean Peel Strength gr/3 inches
T		
1.	13.3	3.5
2.	5.7	3.3
3.	7.4	3.5
B		
1.	10.9	4.7
2.	12.1	4.3
3.	9.5	4.3

The Lincoln three-ply laminate exhibited mean peel strengths between about 3.3 to 5.5 gr/3 inches, a level generally considered adequate for commercial uses such as novelty paper napkins.

We have found that proper choice of raw materials and control of certain selected processing conditions is essential to successfully practicing our invention. The most important parameters are adhesive type, viscosity and set time; adhesive coverage; carrier sheet basis weight and air flow measured using the air flow test described above. We have found that appropriate adjustment of parameters provides controlled strike-through of adhesive and enables manufacture of multi-ply laminates using only one adhesive application for multiple junctures between plies.

More specifically, where a carrier sheet with a lower airflow is used it is usually necessary to reduce the viscosity of the adhesive; to increase the adhesive area coverage or the size of the adhesive dots used in order to ensure adequate

strike-through. For exterior sheets where strike-through is not wanted, a low airflow (preferably below 50 CFM) should be used. The adhesive set time must be such that setting does not occur between the adhesive application point and the nip above the bottom calendar roll. For most applications, adhesive coverages above 0.5% are adequate, and the pattern of the rubber mat should be selected accordingly.

EXAMPLES

Following the procedures set forth above, three tests were made using Shawano paper plies. National Starch and Chemical Company's PVA adhesive no. 18-1535 was used full strength. It has a viscosity of 2500 centipoise. The dot pattern shown in Figure 5, with 1/16 inch dots, was used to provide an area coverage of 3.1%.

In the following examples, the peel strength tests labelled "T" measured the strength of the original adhesive pattern labelled and denoted by reference number 6 in Figure 1, while the peel strength labelled "B" measured the strength of the struck-through adhesive pattern labelled reference numeral 7 in Figure 1.

Example 1

The process of our invention was used at the conditions set forth above to make a three-ply laminate from unconverted Shawano EXtraBond™ paper having a basis weight of 9.7 lbs/3000 ft^2 and an air flow of 120-140 CFM. The following results were obtained:

Shawano EXtraBond™ - Not Converted

	Maximum (Peak) Peel Strength gr/3 inches	Mean Peel Strength gr/3 inches
T		
1.	132.1	30.6
2.	151.9	37.7
3.	156.1	34.9
B		
1.	166.7	33.0
2.	93.0	24.6
3.	77.5	22.9

The peel strength of the resulting laminate was appreciably superior to that of the commercially available Lincoln converted laminate.

Example 2

Peel strength tests were also performed on the same three-ply laminate after conversion to napkins. The following results were obtained:

Shawano EXtraBond™ - Converted - no color

	Maximum (Peak) Peel Strength gr/3 inches	Mean Peel Strength gr/3 inches
T		
1.	77.1	22.7
2.	102.1	25.7
3.	61.5	23.1
B		
1.	55.4	9.3
2.	33.9	8.7
3.	40.3	12.9

Example 3

We also conducted field strength tests on napkins converted from the same three-ply laminate, having a printed Minnie Mouse pattern. The following results were obtained:

Shawano EXtraBond™ - Converted - with color

	Maximum (Peak) Peel Strength gr/3 inches	Mean Peel Strength gr/3 inches
T		
1.	115.3	24.9
2.	104.3	30.5
3.	99.7	25.3
B		
1.	31.9	8.9
2.	56.2	12.2
3.	40.2	9.9

As the foregoing examples demonstrate, our invention produces peel strengths well in excess of those created by conventional processes using two adhesive application steps. Moreover, the ratio of peel strengths is well in excess of 20 percent.

It will be apparent to those of ordinary skill in the art that many changes and modifications could be made while remaining within the scope of our invention. We intend to cover all such equivalent laminates and processing methods, and to limit our invention only as specifically delineated in the following claims.

CLAIMS

We claim:

1. A paper laminate structure comprising a carrier sheet having a first surface and a second surface; an initial adhesive pattern applied to said first surface; a third ply overlying said second surface; a first ply underlying said adhesive pattern; and a struck-through adhesive pattern between said second surface of said carrier sheet and said third ply created by controlled strike-through of said initial adhesive pattern.

2. The paper laminate structure of claim 1 wherein the peel strength of said struck-through adhesive pattern is at least about 20 percent of the peel strength of said initial adhesive pattern.

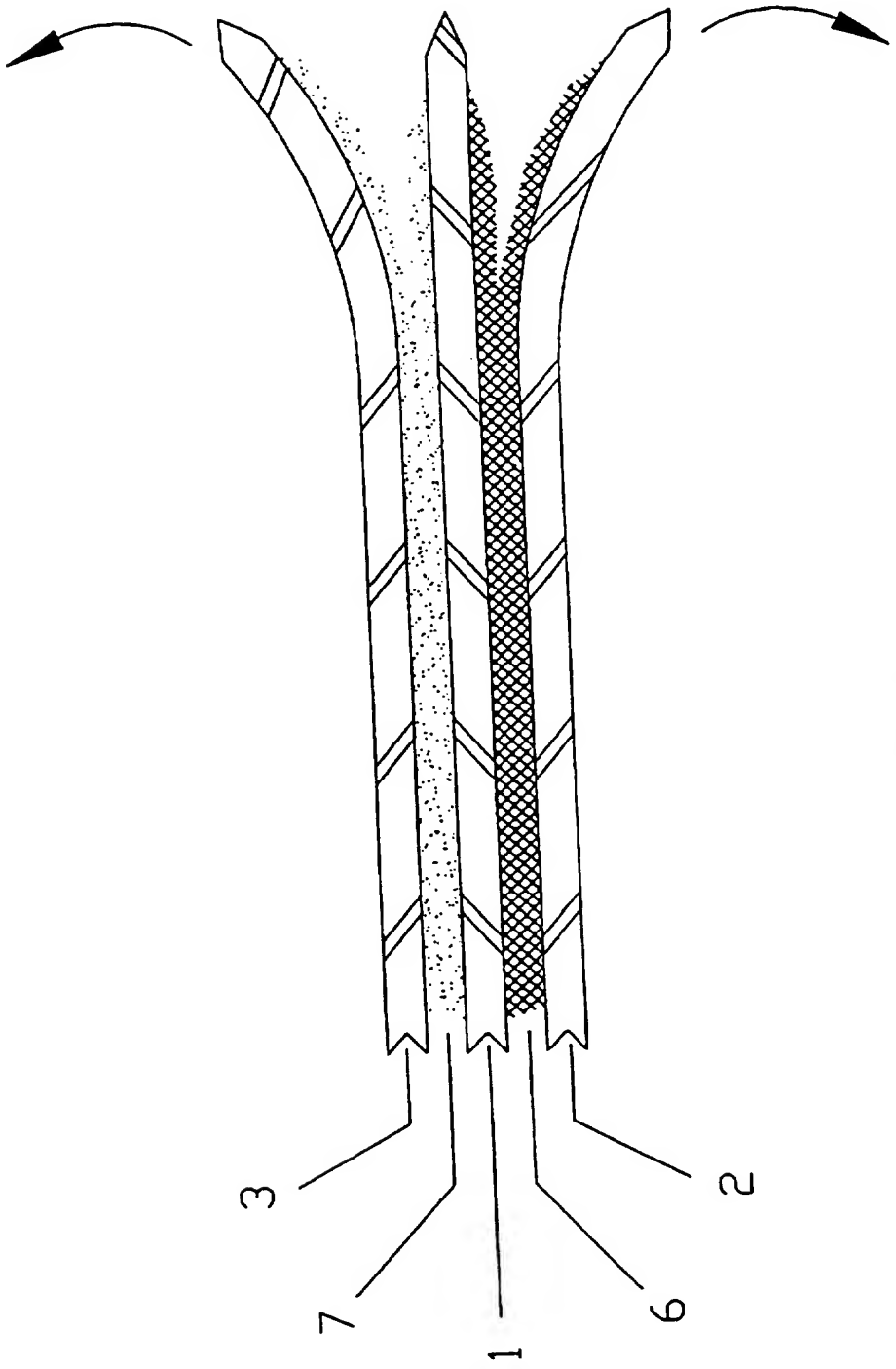


FIGURE 1

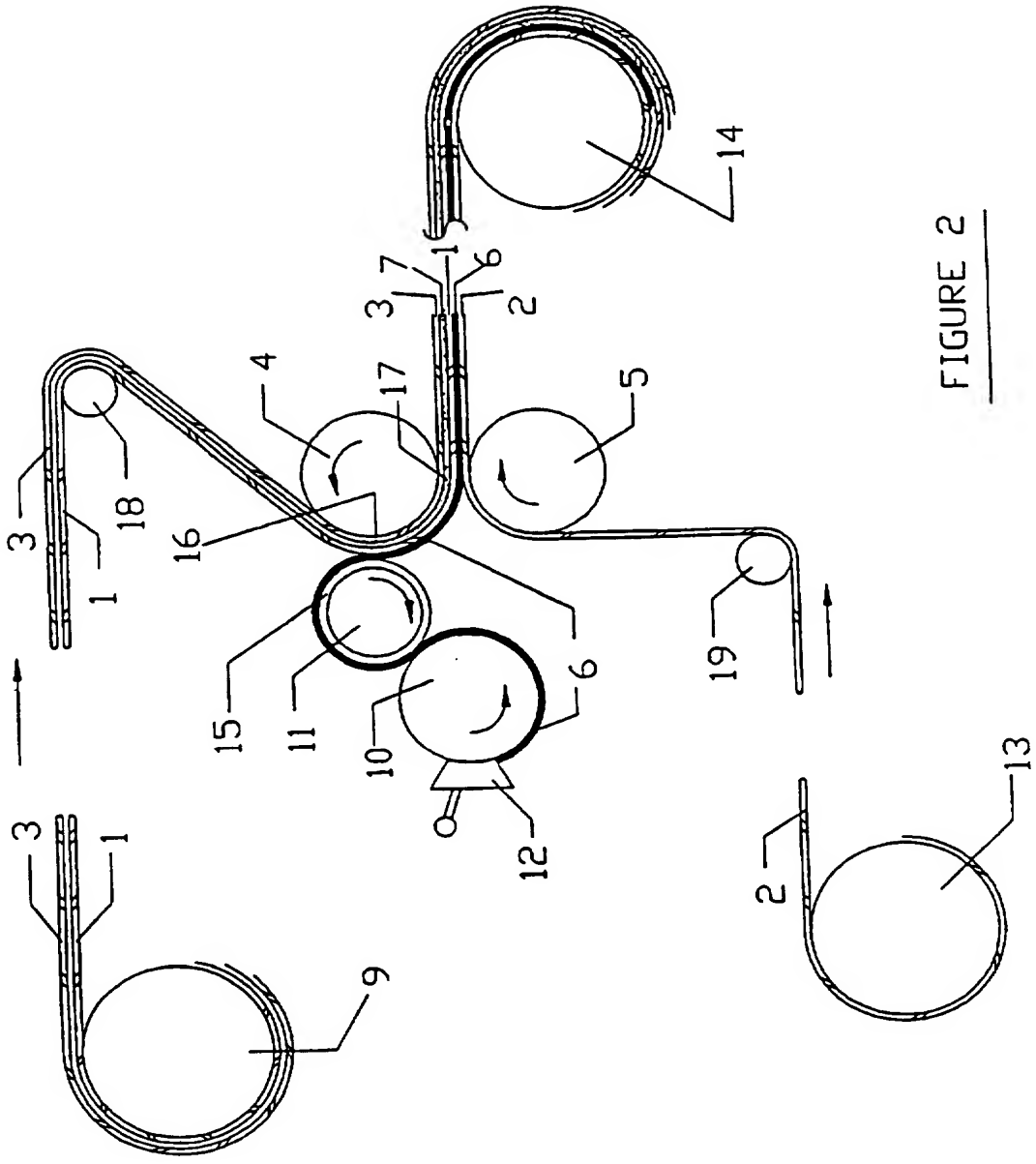
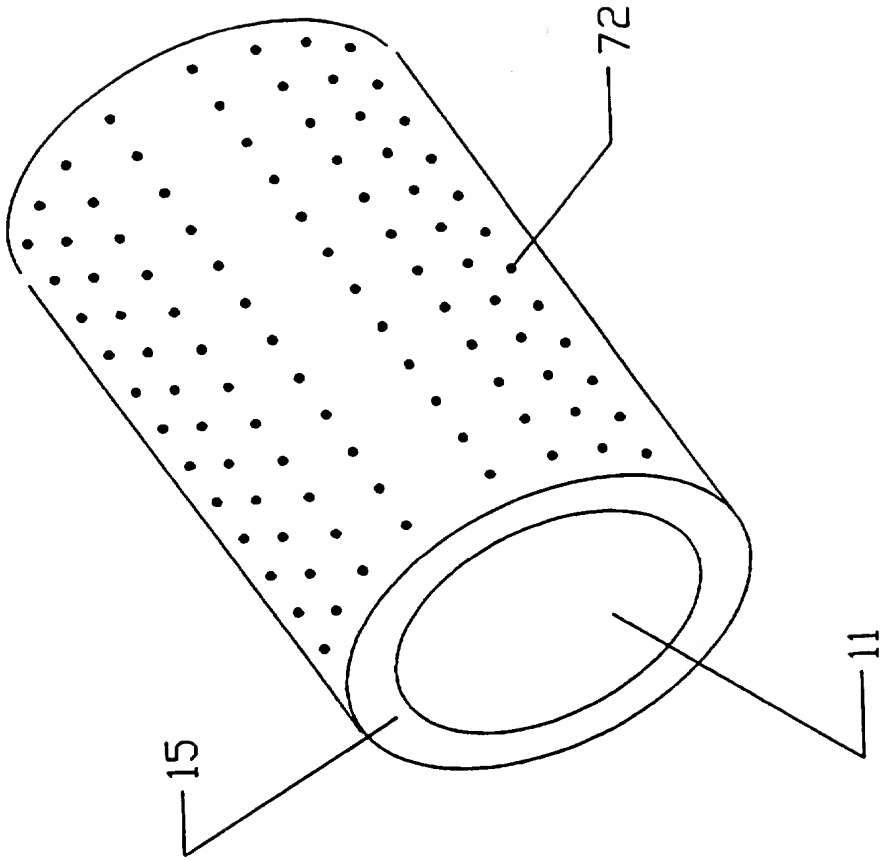


FIGURE 2

FIGURE 3



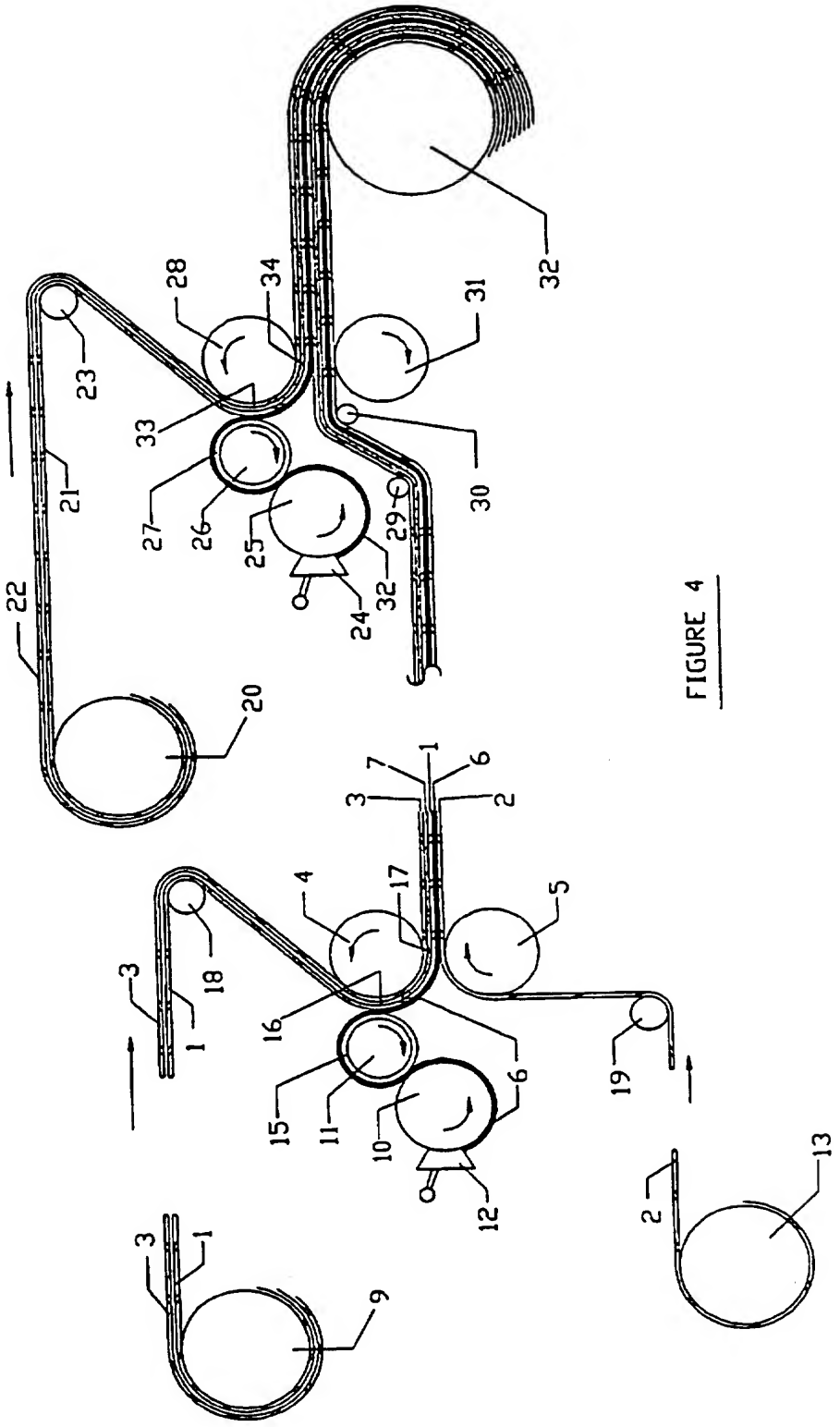

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FIGURE 4

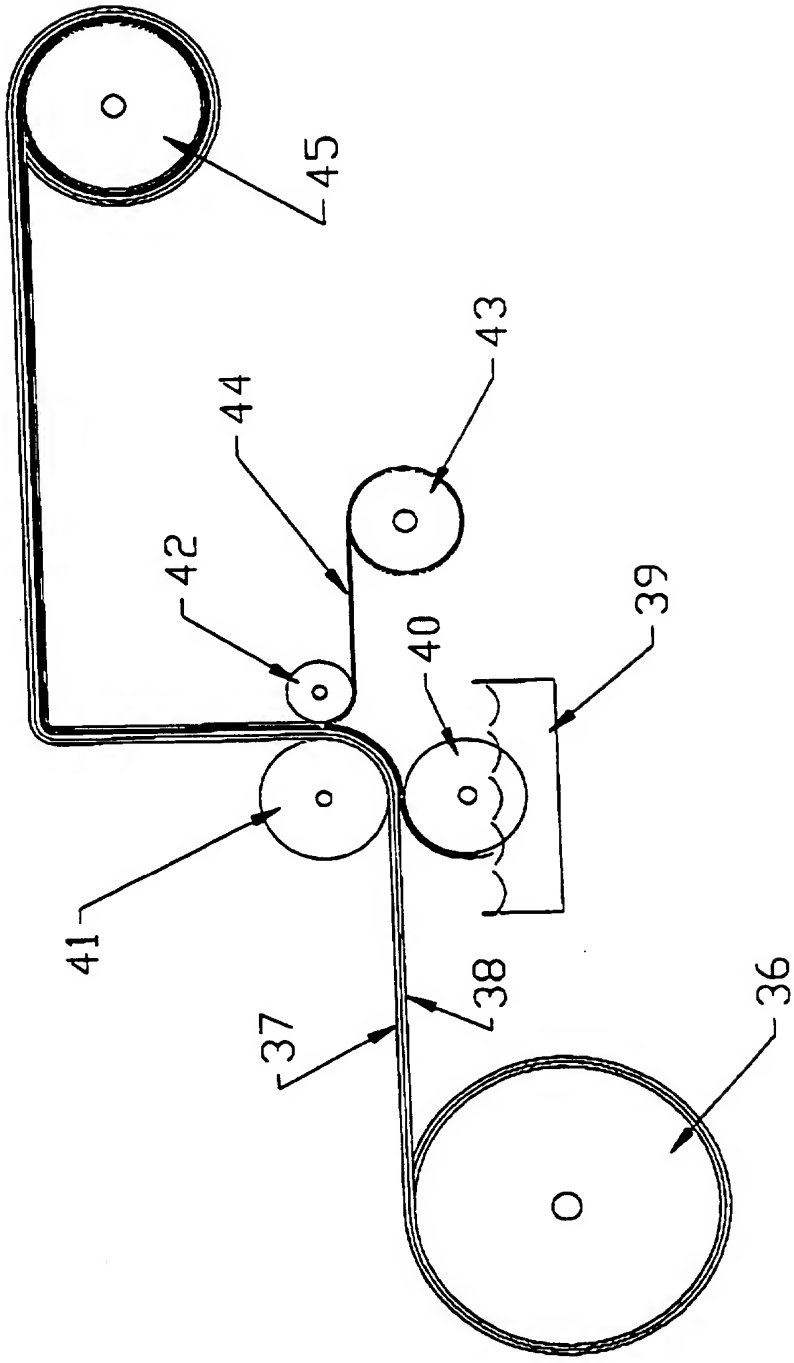


FIGURE 5

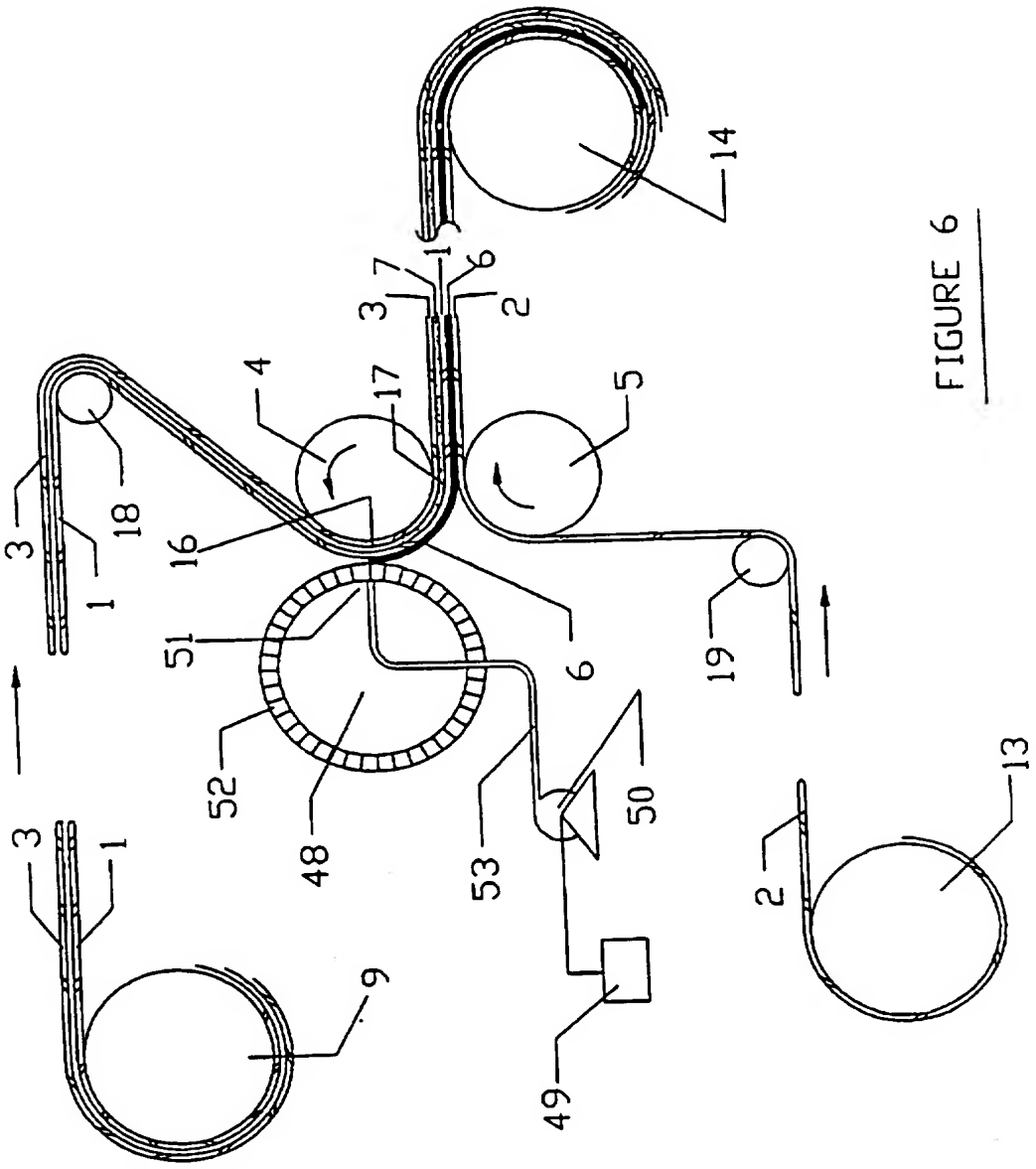
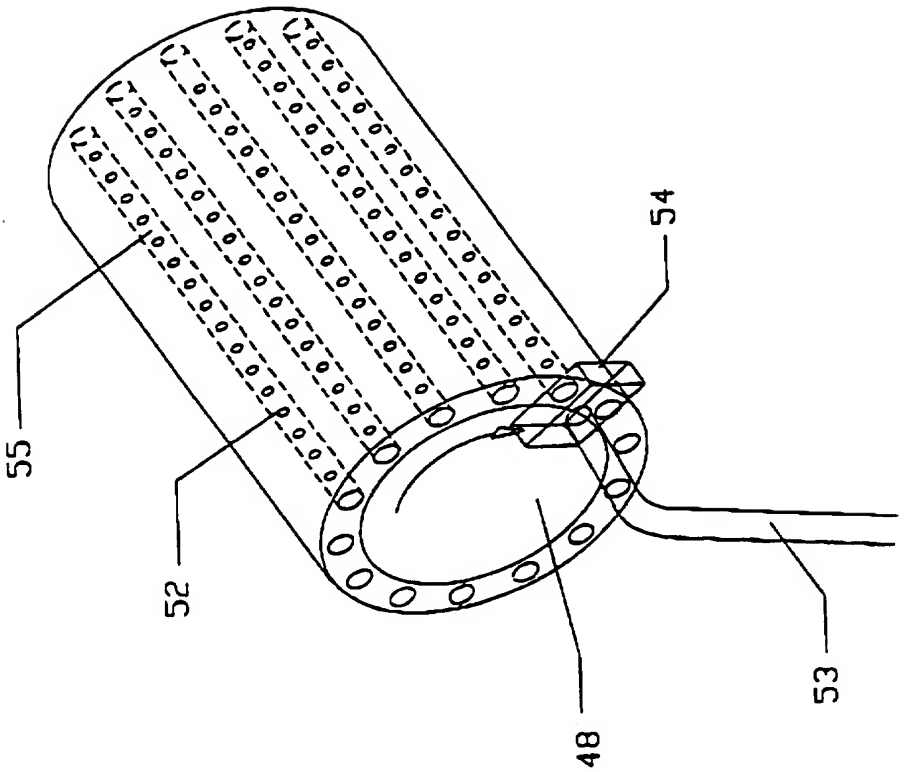


FIGURE 6

FIGURE 7



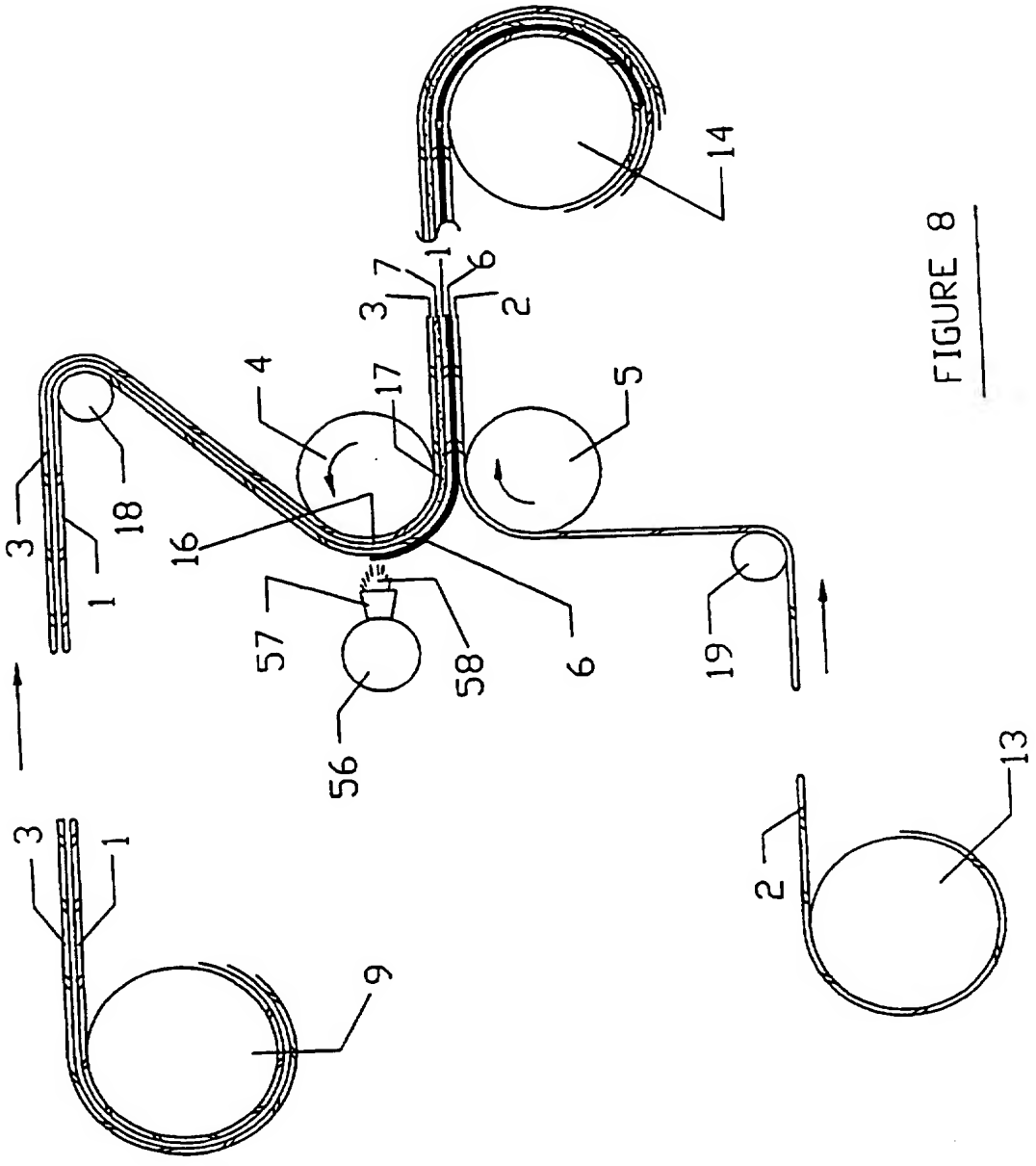


FIGURE 8

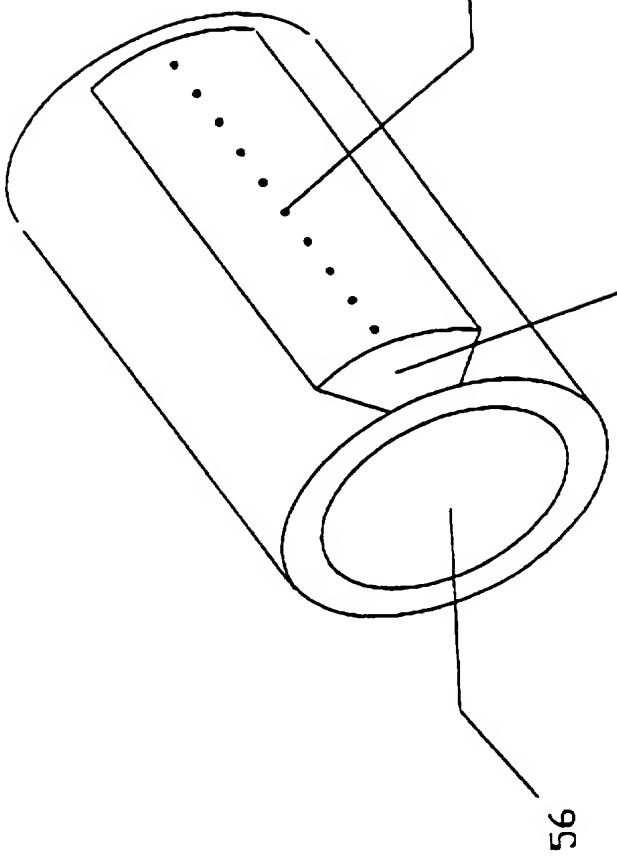


FIGURE 9

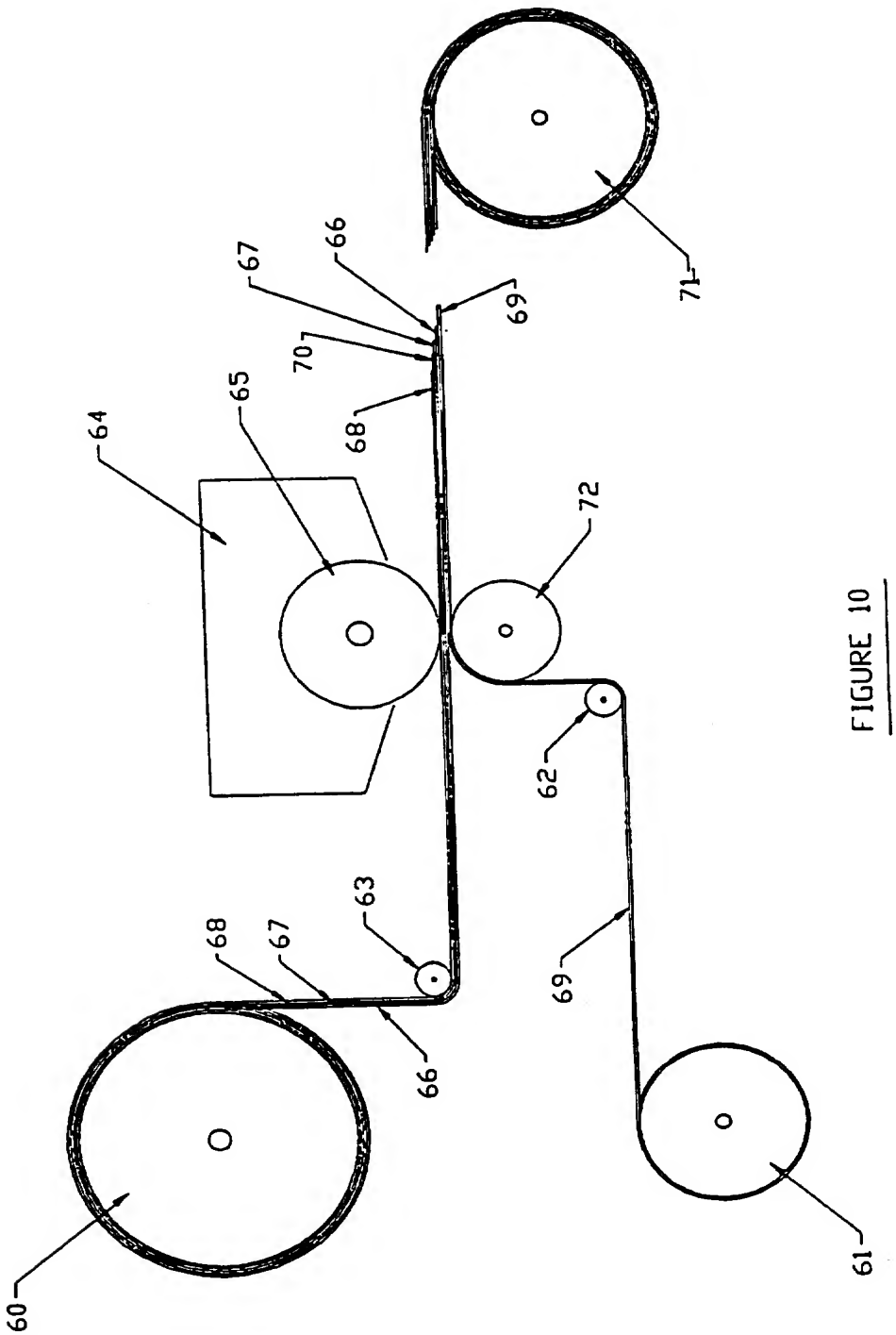


FIGURE 10

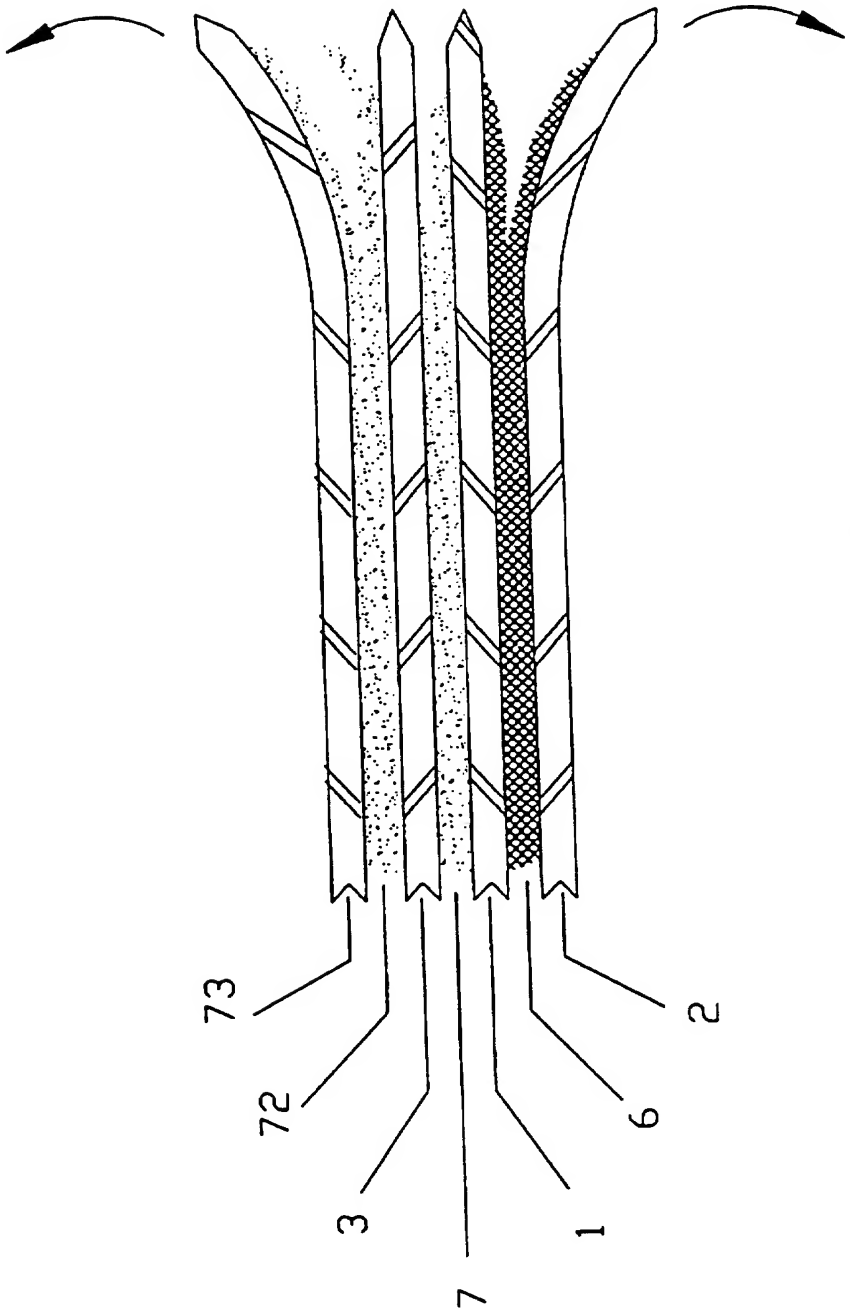


FIGURE 11

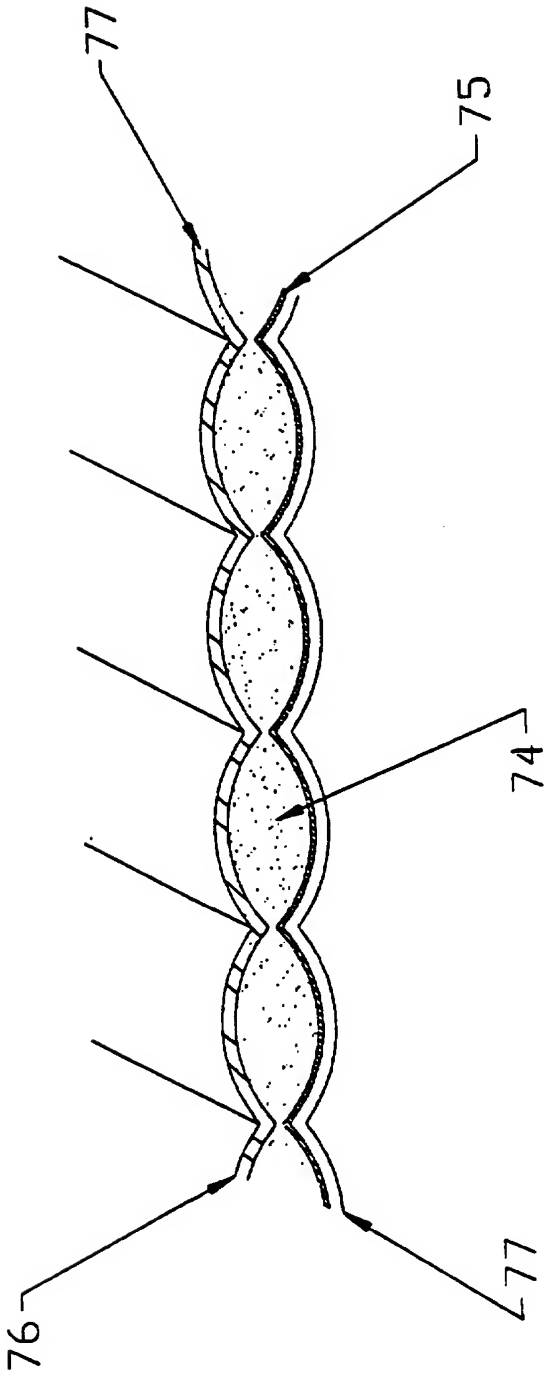
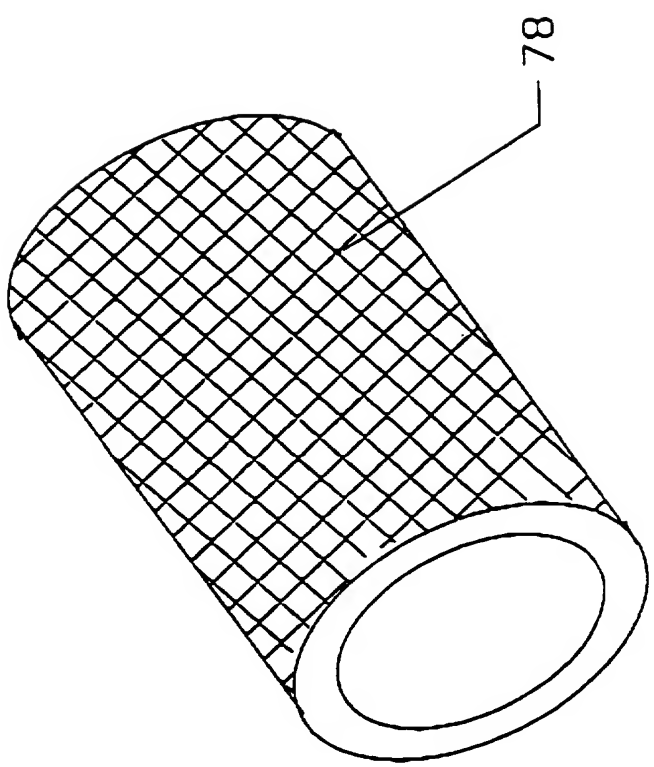


FIGURE 12

FIGURE 13



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/01812

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B32B 7/10, 9/06, 23/06
US CL :428/103, 198, 211, 212, 311.1, 311.9
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 428/103, 198, 211, 212, 311.1, 311.9

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

None

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

None

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4,232,074 (CHAVANNES) 04 November 1980, see entire document.	1, 2
A	US, A, 5,240,562 (PHAN ET AL.) 31 August 1993, see entire document.	1, 2
A	US, A, 3,673,060 (MURPHY ET AL.) 27 June 1972, see entire document.	1, 2

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
19 APRIL 1996

Date of mailing of the international search report
13 MAY 1996

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